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Safety Knowledge of Domestic Liquefied Petroleum Gas (LPG) Users in Ghana – A Case Study

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Abstract

Liquefied Petroleum Gas (LPG) is one of the most common and an alternative fuel used in comercial, industrial and domestic sectors. It has proved itself to be one of the most cost-effective and less pollutant fuel. When used carefully, it is risk-free. However, due to some of its properties, LPG usages have been associated with periodic incidents due to improper handling. This study aimed at assessing the safety knowledge of domestic LPG users in Ghana using Tarkwa as a test case. Descriptive survey design was adopted for the study. The main instruments for data collection were questionnaires and personal interviews. The questionnaires were administered to 200 domestic LPG users through random sampling technique. The study revealed that domestic users of LPG lack knowledge on safety procedures for connecting and disconnecting LPG cylinder, detecting leaks, lighting LPG appliances and other important safety related issues. It is recommended that LPG safety programmes should be organised by the Government and Non-Governmental Organisations (NGOs) to educate domestic LPG users on the safe handling of LPG.

Keywords: Domestic; Incident; Liquefied Petroleum Gas; Safety.

1. Introduction

Liquefied Petroleum Gas (LPG) is one of the most common and an alternative fuel used in the world today [1]. Liquefied Petroleum Gases (LPGs) are by-products of natural gas productions and refineries. LPGs mainly consist of mixtures of hydrocarbons such as propane (C_3H_8), propene (C_3H_6), *n*-butane (C_4H_{10}), isobutene (methyl-propane), and various proportions of other butanes (C_4H_8) [2]. Most commercial applications employ either propane or butane [3]. LPGs are combustible and highly flammable [4]. LPG has an explosive range of 1.8% to 9.5% volume of gas in air which is considerably narrower than other common gaseous fuels. This gives an indication of hazard of LPG vapour accumulated in low lying area in the eventuality of a leakage [5]. LPG is commonly stored under pressure, and therefore it can leak from any improperly sealed connection [4]. LPG has many domestic, commercial and industrial usages because it is one of the most cost-effective, pollution free and when used carefully, it is risk-free.

However, due to some of its properties and poor handling, LPG usages have been associated with periodic incidents. LPG must be used in accordance with certain safety measures. Improper handling of LPG can result in incidents such as fires, explosions, loss of lives and properties. In 2014, two student nurses died at Nyaniba Healthcare Training School at Tema in Ghana as a result of a gas cylinder explosion [6]. Between 2007 and 2015, about ninety-six (96) persons died while 486 sustained various degrees of injuries in only 19 reported cases involving LPG explosions [7]. Out of the 19 reported cases, nine involved industrial settings (gas stations, fuel stations and a fuel dump), while six were gas tanker crashes, with the remaining four being domestic accidents. The domestic accidents could be triggered by several factors, including the accumulation of leaking gas tubes, incorrect regulator installation,

damaged regulators, incorrect method of storage of LPG cylinders, incorrect cylinder use, installation location and many more [8]. In spite of the risk associated with LPG usage, LPG can be used safely if simple safety procedures and rules are adhered to. This research work is conducted to determine the safety knowledge of domestic LPG users in Ghana using Tarkwa as a test case. This work creates a general awareness of safety issues and safety knowledge of domestic LPG users.

2. The study area

Tarkwa, the capital of the Tarkwa-Nsuaem Municipality in the Western Region of the Republic of Ghana is a town in the south-western part of Ghana. Tarkwa is a town which is blessed with gold and manganese and therefore has lots of mining companies like Goldfields Ghana Limited (GGL), Anglo-gold Ashanti (AGA) and Ghana Manganese Company (GMC). The inhabitants are mainly into mining of these minerals and agriculture. Tarkwa has a 2016 settlement population of about 41,345 people. The municipality is situated between latitudes 4° 0′ 0″N and 5° 40′ 0″N and longitudes 1° 45′ 0″W and 2° 1′ 0″W (Figure 1). It is bounded to the north by Wassa Amenfi District, the south by the Ahanta West District, the West by the Nzema East District and the East by Mpohor Wassa East District. Most of the habitants of Tarkwa are migrants from other parts of the country [9-11].

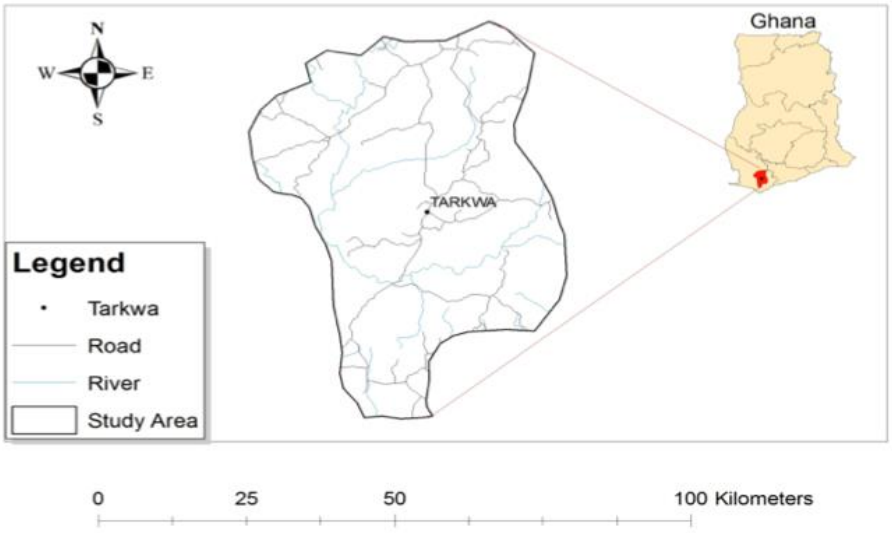

Figure 1. Map Showing the Location of Tarkwa [9]

3. Safety education

Safety education means improving knowledge, skill, attitude and morale of workers or people. It is a process of systematic instructions and development of character or mental powers of the workers or people. It must prevent both unsafe conditions and unsafe acts. Safety training alone is the remedy for correcting unsafe acts [3]. An effective training programme can reduce the number of injuries and deaths, property damage, legal liability, illnesses, workers' compensation claims, and missed time from work [12]. It is generally true that well-trained and careful men may avoid injury on dangerous work than that of the untrained and careless men may be injured under the same condition. Safety is, without doubt, the most crucial investment. It is not what it costs but what it saves. The safety educated person is more likely to regard an accident as being predictable, preventable, and non-accidental. Therefore, safety education plays an important role in preventive measures [3, 13].

4. Methods for the data collection and analysis

This section outlines methods employed for the collection and analysis of the research data.

4.1. Data collection technique

Questionnaire was designed for domestic users of LPG. According to Best and Kahn [14], questionnaire serves as the most appropriate data-gathering device in a research project when properly constructed and administered. The questionnaire which required a "yes" or "no" answer as well as options to choose an answer from was administered to 200 domestic LPG users. The safety knowledge of domestic LPG users was assessed in five (5) major areas as follows:

- Part A: Connecting and Discounting LPG Appliance;
- Part B: Lighting LPG Appliance;
- Part C: Safety Caps;
- Part D: Checks for Leaks; and
- Part E: Time to Change Rubber Tube.

4.2. Data type

Both primary and secondary data were employed for this research. Primary data were obtained from domestic LPG users in Tarkwa through the administration of questionnaires. Secondary data per this research consisted of already existing data from published literature, media reports and government documents. According to Yin [15], no single source of data has a complete advantage over the others but rather they are all highly complementary. Responses to the questionnaires by respondents were done with the help of the researchers in the form of interviews.

5. Analysis of the safety knowledge of domestic LPG users

This section presents the analysis of safety knowledge of domestic LPG users in Tarkwa.

5.1. Safety knowledge on connecting and disconnecting LPG cylinder

Table 1 gives the responses of domestic LPG users to safety knowledge on connecting and disconnecting LPG cylinder. It can be noticed from the given percentages and frequencies that, majority of the respondents tend to respond negatively to all the safety tips that must be adhered to when connecting or disconnecting LPG cylinder. About 78% of the domestic LPG users agreed that they do not check whether valves on appliances are closed before connecting full cylinder. Very few respondents showed safety knowledge on the need to turn regulator to OFF position before connecting (16%) or disconnecting (14%) a cylinder (Table 1).

Table 1. Safety knowledge on connecting/disconnecting LPG cylinder

Connecting/Disconnecting LPG Cylinder	No		Yes		Total
	Freq.	%	Freq.	%	
Do you check for leaks on regulator/tube/tube joint before connecting full cylinder?	106	53.0	94	47.0	*200*
Do you check whether regulator is turned to OFF position before connecting a cylinder?	168	84.0	32	16.0	*200*
Do you check whether all valves on appliance are closed before connecting full cylinder?	156	78.0	44	22.0	*200*
Do you check whether regulator is turned to OFF position before disconnecting a cylinder?	172	86.0	28	14.0	*200*
Have you experienced any safety-related problem in your house when connecting full cylinder?	117	58.5	83	41.5	*200*

Freq. - frequency, % - percentage

5.2. Safety knowledge on lighting LPG appliance

According to Anon [8], the best practice for lighting LPG appliance is to strike the match first before opening the knob of the appliance. This helps to prevent burns caused by sudden rise of flames [16]. Surprisingly, very few people have knowledge on the best and safe way of lighting LPG appliance. Out of the 200 population sampled, only 20.5% of the respondents

have knowledge on the best and the safe way of lighting an LPG appliance. Majority (79.5%) of the respondents agreed that they open the knob of the appliance first before striking the match. This is an unsafe act when lighting LPG appliance (Figure 2).

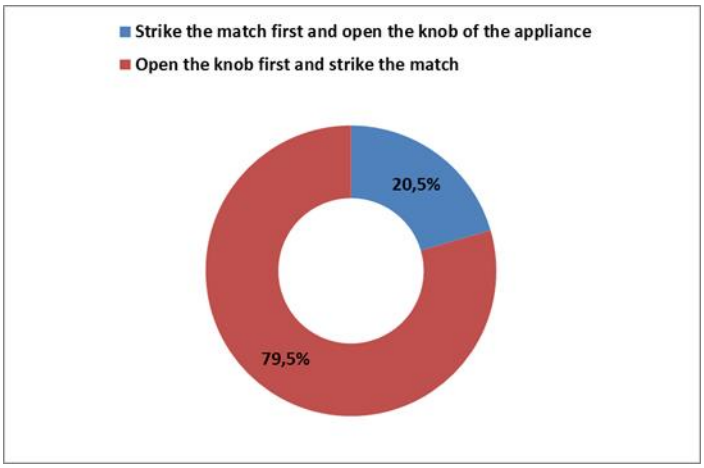

Figure 2. Safety knowledge on lighting LPG appliance

5.3. Safety cap

Safety cap is made from high-grade plastic material and is used to seal and lock LPG valves especially when gas is stored in a cylinder. It is tamper proof and completely plugs the gas to prevent leaks before installing the appliance with a rubber hose/tube. Safety cap also protect gas from ignition and potential fires. Surprisingly, the percentage responses on safety cap were the same in both items. Out of the 200 respondents, 102 respondents representing 51% do not have a safety cap. All the remaining 98 respondents who have safety cap attached to the cylinder (49%) make use of the safety cap (49%) (see Figure 3).

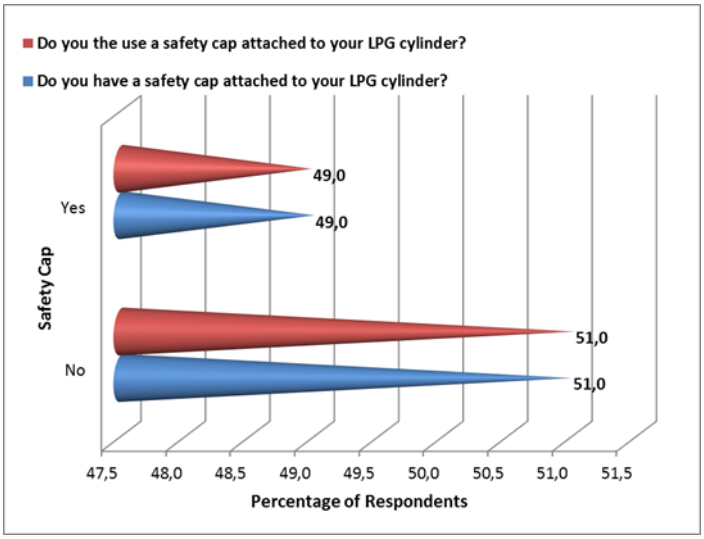

Figure 3. Safety Knowledge on the use of safety cap

5.4. Safety knowledge on leaks

Another major objective of the research was to investigate the safety knowledge of domestic LPG users on checks for leaks. Figure 4 presents the percentages of responses to the questions on how to check for LPG leaks. Higher percentage (67.5%) of the respondents do not have any idea of how to check for leaks whilst 14% do by applying soapy solution which according to Anon [4] is a right procedure for checking leaks. Surprisingly, 18.5% of the

respondents agreed that they use wrong method to check for gas leaks, by using a match. Fortunately, none of the respondents who use match to check for leaks have experienced LPG leaks before.

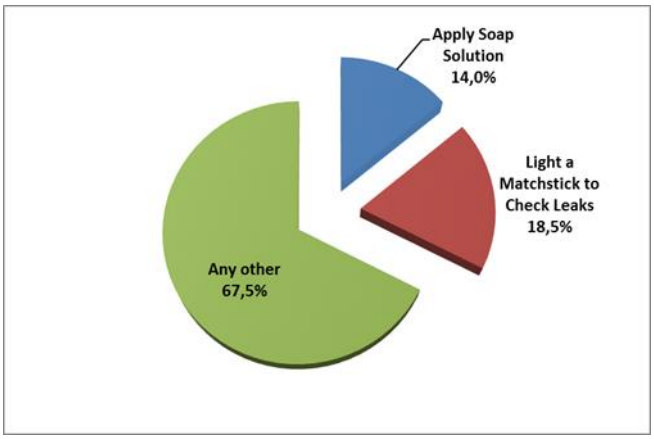

Figure 4. How to check for leaks

Out of the 200 sampled views, 70% of the respondents have never checked for leaks before (Table 2). This affirms the responses on how to check for leaks where 67.5% of the respondents confirmed of not having any idea on the right safety method for checking gas leaks. On the whole, higher percentage (53%) of domestic LPG users has not checked for leaks before and 61% of the respondents do not check for leaks after connecting full cylinder. Similarly, majority (57.5%) of the respondents do not check for leaks on regulator/tube/tube joint before lighting LPG appliance (Table 2).

Table 2. Safety knowledge on leaks

Safety knowledge on leaks	No		Yes		*Total*
	Freq.	%	Freq.	%	
Have you ever checked for cracks (leaks) in your rubber tube before?	108	54.0	92	46.0	*200*
Have you ever checked for gas leaks?	140	70.0	60	30.0	*200*
Do you check for leaks on regulator/tube/tube joint before lighting LPG appliance?	115	57.5	85	42.5	*200*
Have you ever checked for cracks (leaks) after securely connecting a new or refilled cylinder?	122	61.0	78	39.0	*200*
Do you check for leaks on regulator/tube/tube joint before connecting full LPG cylinder?	106	53.0	94	47.0	*200*

Freq. - frequency, % - percentage

5.5. Change of rubber tube

According to Anon [16], rubber tube connecting a cylinder and LPG appliance must be replaced every 18 months while Anon [8], recommends replacement every 6 months. According to the majority (52%) of the respondents, they change rubber tube when a defect is detected and this usually occurs after 36 months. Only 29.5% respondents out of the 200 respondents have safety knowledge on the time to replace LPG rubber tube as recommended by Anon [16]. The recommended period by Anon [8] has never been practiced by domestic LPG users in Tarkwa (Figure 5).

5.6. Safety related issues on LPG usage

Majority (58%) of the respondents have experienced safety issues that are related to the use of LPG (Table 3). The common one being the smell of gas (80.5%) followed by sudden noise of leaks (13.5%) and fire explosion (6%) (Figure 6). According to the majority of the respondents, smell of LPG is a basic clue to detecting leakages (Table 3). This affirms the

research by Biscoff *et al.* [17]. According to Biscoff *et al*. [17], the first safety measure of LPG stakeholders was the detection of smell (mercaptan) of LPG. The smell of the mercaptan is a possible clue to leakage. Generally, the domestic LPG users in Tarkwa deal with LPG related issues on their own (63%) with few consulting the services of trained personnel (Figure 7).

Table 3. Experience any safety related issues

Have you experienced any safety related issues before?	Frequency	Percentage
No	84	42
Yes	116	58
Total	*200*	*100*

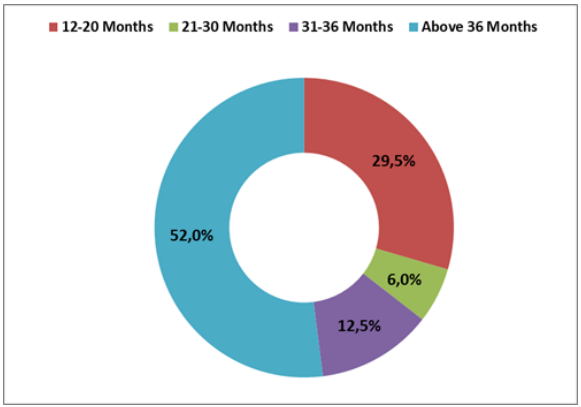

Figure 5. Safety knowledge on the Time to change rubber tube

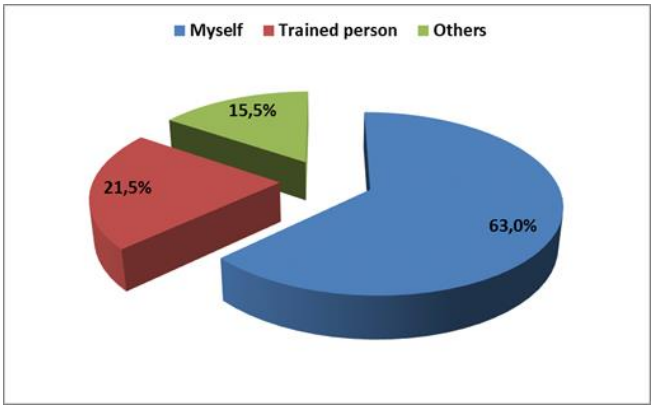

Figure 7. Dealing with safety related issues

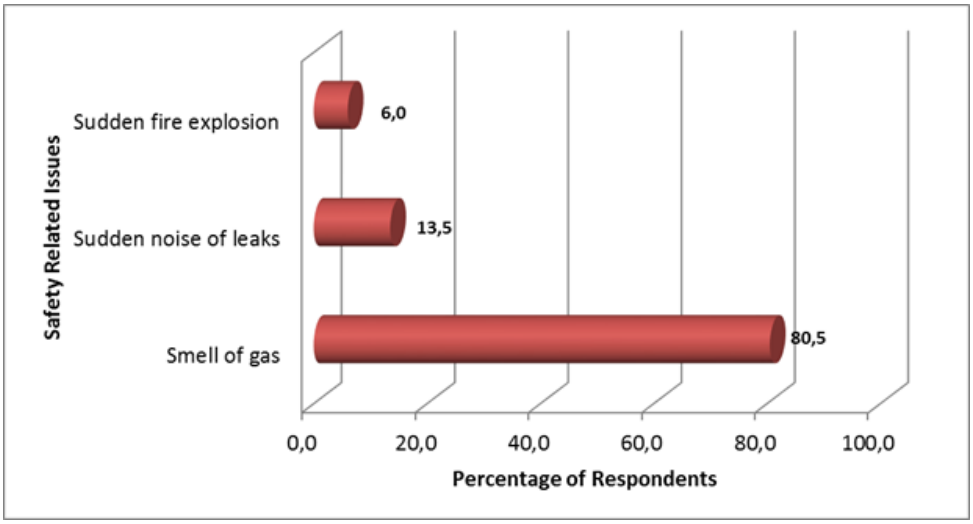

Figure 6. Safety related issues

5.7. Other safety related issues

The research also revealed other equally important safety issues which are clearly presented in Table 4. Majority of the domestic users have their cylinders vertically positioned (93.8%) which is recommended as the best practice for handling LPG cylinders [8, 16]. Higher percentage (81.5%) of respondents has adequate ventilation at the floor and the top level where LPG cylinder and appliance are placed. However, it was observed that some users have a well ventilated area but poorly positioned cylinder and vice versa. Other views of the respondents are presented in Table 4.

Table 4. Other safety related issues

Items	No		Yes		Total
	Freq.	*%*	*Freq.*	*%*	
Do you know the expiry date of your gas bottle (cylinder)	168	89.8	19	10.2	*187*
While receiving a gas cylinder, do you check whether the gas cylinder is delivered with the company seal?	126	66.7	63	33.3	*189*
In the last 12 months, have you seen, read or heard any information about the safe use of gas stoves and cylinder?	130	68.8	59	31.2	*189*
Is the LPG appliance installed at a level higher than the LPG cylinder?	50	26.9	136	73.1	*186*
Do you store kerosene or other flammable equipment in your kitchen?	152	79.2	40	20.8	*192*
Is there adequate ventilation at the floor and the top level where LPG cylinder and appliance are placed?	35	18.5	154	81.5	*189*
Do you turn your valve on when cylinder is not in use?	113	59.5	77	40.5	*190*
Is your cylinder exposed to sun, rain, dust and heat?	168	89.8	19	10.2	*187*
Is your cylinder vertically positioned	12	6.2	181	93.8	193

Freq. - frequency, % - percentage

6. Conclusions

From the research conducted, it is concluded that majority of domestic LPG users:

(i) Do not follow strict safety procedure before connecting or discounting LPG cylinder.
(ii) Do not have safety cap on their cylinders.
(iii) Do not have adequate knowledge on how to detect LPG leakages.
(iv) Do not have good response plan for fire explosions and accidents.
(v) Use poor procedure for lighting LPG appliances.

In general, domestic LPG users lack the required safety knowledge to handle LPG.

7. Recommendations

Based on the conclusions, the following are recommended:

(i) LPG usage education programmes should be organised regularly by the Government and Non-Governmental Organisations to educate people on safest ways for handling LPG.
(ii) Only certified companies should be allowed to sell LPG appliances in order to check for quality and safety of items.
(iii) Rubber tubing connected to LPG cylinders should be checked and changed at the appropriate time intervals.
(iv) To minimise risks, a manual must be provided in addition to the cylinders by the dealers of LPG appliances.
(v) Each house should be equipped with fire extinguishers to combat fire should there be.

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